CLAIMS:

1. A layered structure, comprising:

a substrate having a crystal layer, and

a crystalline compound film, which is epitaxially grown on a principal face of the crystal layer, whose orientation follows the orientation of the crystal layer, which has a crystal lattice that does not match a lattice of the crystal layer, and which has a larger bonding strength between atoms than the crystal layer.

2. The layered structure according to claim 1, wherein the crystalline compound film is a group-III element nitride film.

3. The layered structure according to claim 1 or claim 2, wherein the crystal layer is a Si crystal layer, and the principal face of the Si crystal layer is the (111) plane.

4. The layered structure according to claim 3, wherein the crystalline compound film is an AlN film.

5. A method for manufacturing a layered structure, comprising:

alternately repeating a step (a), wherein a first atom layer of either a group-III element atom layer or a N atom layer is formed on a principal face of a crystal layer

of a substrate; and

a step (b), wherein a second atom layer of the other of the group-III element atom layer or the N atom layer is formed on the first atom layer;

thereby epitaxially growing a crystalline group-III element nitride film on the crystal layer.

6. The method for manufacturing a layered structure according to claim 5, wherein in the step (a) a N atom layer is formed, and

wherein in the step (b) a group-III element atom layer is formed to epitaxially grow a crystalline group-III element nitride film on the crystal layer, wherein the crystalline group-III element nitride film has a crystal lattice not matching the crystal lattice of the principal face of the substrate.

7. The method for manufacturing a layered structure according to claim 6, wherein the crystal layer is a Si crystal layer, and

wherein the principal face of the Si crystal layer is the (111) plane.

8. The method for manufacturing a layered structure according to claim 7, wherein in the step (b) an Al atom layer is formed, thereby forming an AlN film as the nitride film.

9. The method for manufacturing a layered structure according to any of claims 6 to 8, wherein deposition of the N atom layer is performed by a molecular beam epitaxy (MBE) method, in which radical nitrogen made by turning nitrogen gas into a plasma is supplied to the principal face of the crystal layer.

Sub a1

10. The method for manufacturing a layered structure according to claim 11, wherein the nitrogen gas is turned into a plasma using a plasma cell.

11. A method for manufacturing a layered structure, comprising:

a step (a), wherein a principal face of a Si crystal layer of a substrate is exposed to an atmosphere including one of nitrogen, hydrogen, sulfur and magnesium, to terminate dangling bonds on the primary surface of the semiconductor substrate; and

a step (b), wherein a crystalline AlN layer is formed on the Si crystal layer.

12. The method for manufacturing a layered structure according to claim 11, further comprising a step before the step (b), wherein a principal face portion of the Si crystal layer is nitrogenized to form a silicon nitride layer; and

wherein in the step (b), a crystalline AlN layer is formed on the silicon nitride layer.

Sub a2

13. The method for manufacturing a layered structure according to claim 12 or claim 13, wherein in step (b) at least one of oxygen, hydrogen and sulfur is added to the AlN film to relieve strain in the AlN layer resulting from lattice mismatch with the Si crystal layer.

14. A semiconductor element, comprising:

a substrate having a semiconductor layer;

an insulating film provided on the semiconductor layer and having an AlN layer; and

an electrode provided on the gate insulating film and made from a conductor.

15. The semiconductor element according to claim 14, wherein the AlN layer is a monocrystalline layer epitaxially grown on the semiconductor layer.

16. The semiconductor element according to claim 15,

wherein the semiconductor layer is a Si crystal layer;

wherein the principal face of the semiconductor layer is the (111) plane; and

wherein the AlN layer is a dense hexagonal crystal whose principal face is the (0001) plane.

17. The semiconductor element according to claim 15,

wherein the semiconductor layer is a Si crystal layer;

wherein the principal face of the semiconductor layer is the (100) plane; and

wherein the AlN layer is a cubic crystal whose principal face is the (100) plane.

18. The semiconductor element according to claim 14, wherein dangling bonds at the surface of the semiconductor layer are terminated by one of aluminum, nitrogen, hydrogen, sulfur and magnesium.

19. The semiconductor element according to any of claims 14 to 18,

wherein the insulating film is a gate insulating film; and

wherein the semiconductor element further comprises a silicon nitride layer interposed between the AlN layer and the semiconductor layer.

20. The semiconductor element according to any of claims 14 to 18,

wherein the insulating film is a gate insulating film; and

wherein the semiconductor element further includes a

dielectric layer formed on the AlN layer, wherein the dielectric layer is made of at least one of a dielectric material with a higher dielectric constant than AlN and a material with ferroelectric properties.

21. The semiconductor element according to any of claims 14 to 18,

wherein the insulating film is a gate insulating film;

wherein the semiconductor element further includes a dielectric layer formed on the AlN film, wherein the dielectric layer is composed of at least one of either a dielectric material with a higher dielectric constant than AlN or a material with ferroelectric properties; and

wherein a conductive film with crystallinity is provided above or below, or above and below the dielectric layer.

22. The semiconductor element according to claim 14,

wherein the AlN layer includes at least one of oxygen, hydrogen, and sulfur, and

wherein strain in the AlN layer resulting from lattice mismatching with the semiconductor layer is relieved.

23. The semiconductor element according to claim 14, wherein the lattice mismatch between the AlN layer and the

semiconductor layer is expanded to increase the dielectric constant of the AlN layer.